VI. BIRDS

Of all birds in the Galveston Estuary area, colonial waterbirds are the best documented and potentially the best indicators of the health of the estuary. They are highly visible, sensitive to environmental changes in nesting or feeding habitat, and high on the food chain (therefore likely to bioaccumulate contaminants). Declining trends in those colonial waterbirds that feed at the marsh-bay interface suggest recent reductions in tidal marsh habitat and/or habitat quality and/or marsh prey species. The probable causes for the general decline in northern pintails and green-winged teal probably lie beyond the Galveston Estuary, but declines in non-migratory mottled ducks are driven by conditions within Texas, such as salt water intrusion into nesting habitat.

Given the high mobility of birds, it is inappropriate to evaluate the health of a species based on data from a geographic area as small as a single estuary. However, when the question concerns the health of the estuary (not of a species), birds are appropriate indicators.

COLONIAL WATERBIRDS

Trend analyses by Slack et al.

The initial study by Slack et al. (1992), "Status and Trends of Selected Vertebrate Resources in the Galveston Estuary: Birds and Alligators", showed a decreasing trend in total numbers of certain colonial waterbirds based on data from the Texas Colonial Waterbird Survey: snowy egrets, Egretta thula; black skimmers, Rynchops niger; tricolored herons, Egretta tricolor; and roseate spoonbills, Ajaia ajaja (Figures 25, 26, 27, 28). There was also a decrease in the number of birds per colony for these species plus great egrets (Casmerodius albus; Figure 29), suggesting a change in the structure of the colonial waterbird community. Olivaceous cormorants (Phalacrocorax brasilianus) were exceptional among colonial waterbirds in showing an increase (Figure 30). Among the waterfowl, mottled ducks (Anas fulvigula), northern pintails (Anas acuta), and blue-winged teal (Anas discors) declined in abundance based on the Mid-winter Waterfowl Transects (Figures 31, 32, 33), reflecting a widespread trend that has been cause for concern on the national level (Figure 34). At least six species of shorebirds appeared to be stable or possibly increasing.

Subsequent work by Slack et al. (in prep.) focused on the Texas Colonial Waterbird Survey, the most robust data set available on estuarine birds. There was no significant trend in the total numbers of birds and little or no trend in species richness from 1973 through 1990. However, a detrended correspondence analysis (using the methodology of Spendelow et al. 1989) revealed significant changes in species and habitat associations. Birds with similar population trends fell into three different groups, each with similar feeding habitats.

1) An inland group (little blue herons, white ibises, cattle egrets, white-faced ibises, and great blue herons) was composed of freshwater marsh feeders and generalists. There was no significant change in the number of individuals or the percentage of them in the community overall. The number of colonies containing these species increased, but in those colonies where they are present, their proportion in the colony decreased.

2) An open-water group (royal terns, Caspian terns, olivaceous cormorants, Forster's terns, and Sandwich terns) was mainly composed of open-bay fish-eating birds. The number of individuals, the number of colonies occupied by them, and the number of them in the community overall increased. The percentage of their representation in the colony showed no significant change. Black-crowned night herons, though marsh-feeding birds, unexpectedly clustered with this open-water group.

3) A marsh group (tricolored herons, snowy egrets, black skimmers, roseate spoonbills, and great egrets) was made up of birds that feed on small fish and invertebrates at the marsh-bay interface. This group declined both in total numbers and the proportion the composed in those colonies where they occur. The number of colonies containing them increased but the mean colony size decreased (Figures 25, 26, 27, 28, 29). All these are wading birds except black skimmers, which fell into this group probably because they feed in nearshore areas where the water surface is smooth rather than in rougher open bay waters.

Least terns were outliers in this analysis, probably because they are more opportunistic nesters than strictly colonial and are therefore difficult to count accurately. Laughing gulls are generalists that showed no population trend and were not associated with declining species.

Slack et al. (in prep.) concluded that feeding habitat, not nesting habitat, was probably the controlling factor in the observed trends, because most of the colonial waterbird species nest together. The decline in marsh-feeding birds is probably correlated with wetland loss. Although nesting habitat is not suspected of being the controlling factor in the Galveston Estuary, it can be crucial on a more local scale (Mike Lange, pers. comm.). The problems of waterbird colonies in the Galveston Estuary area are well documented: rookeries have been lost to subsidence or erosion, disturbed by humans, invaded by fire ants, or decimated by mammalian predators. Nesting habitat is undeniably important, though not necessarily a driving force of the estuary-wide trend.

Reliability and temporal extent

Texas Colonial Waterbird Survey data have been analyzed independently by Glass (1992), Telfair (in press), and Lange (in review). Their analyses corroborate the results of Slack et al. (in prep.). The decline in black skimmers has also been observed elsewhere (King and Krynitsky 1986).

Telfair (in press) concentrated on inland bird colonies and the possible influence of the cattle egret on colony life span. He found that excluding colonies for which there were incomplete censuses (mainly inland colonies) changed the magnitude, but not the slope,

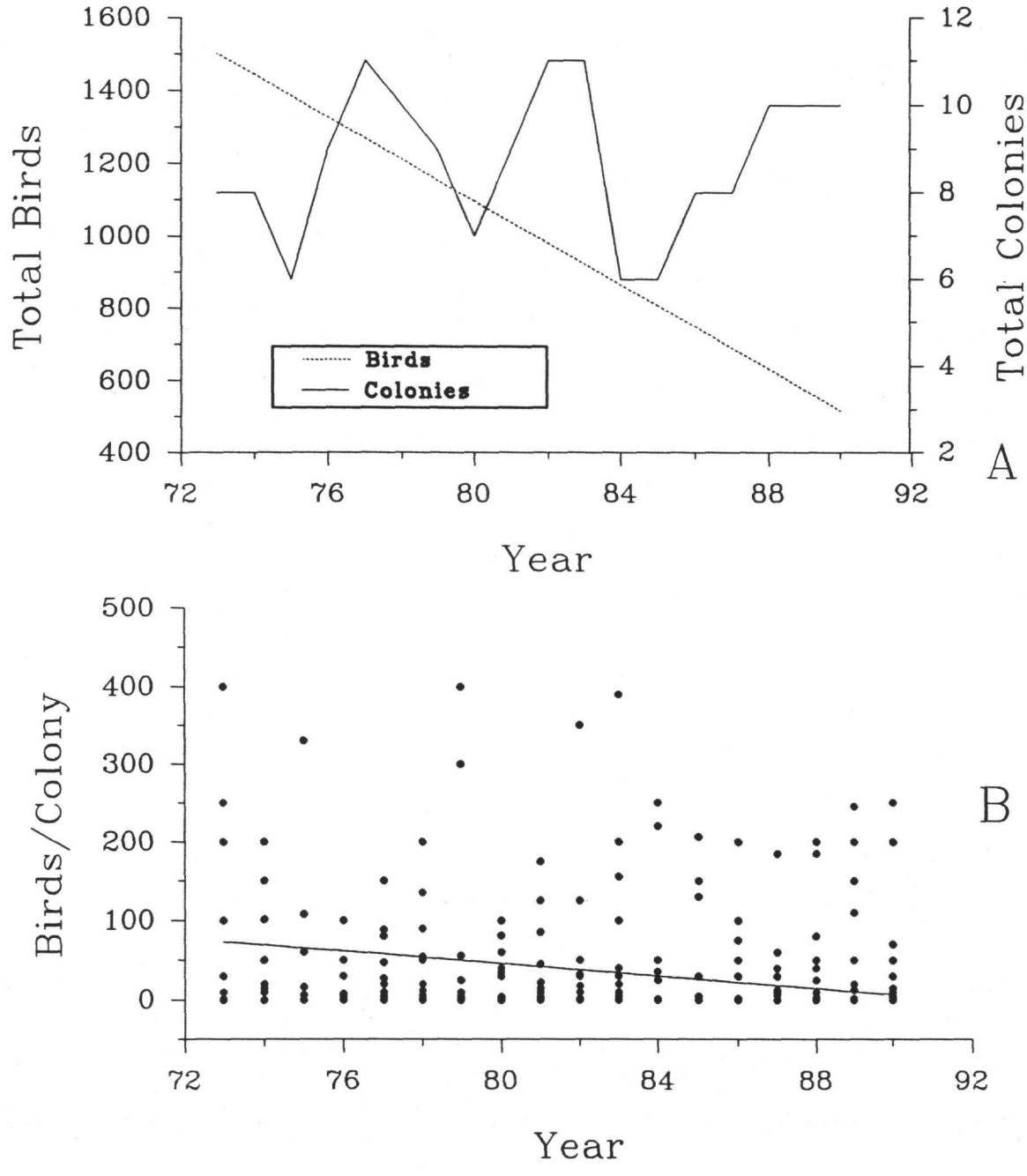

Figure 25. A. Trend in snowy egrets per year (N=18) and the number of colonies containing snowy egrets from 1973 to 1990 during Texas Colonial Waterbird Surveys. B. Individual colony counts and trend in snowy egrets per colony from 1973 to 1990 (N=516) during Texas Colonial Waterbird Surveys. From Slack et al. (1992).

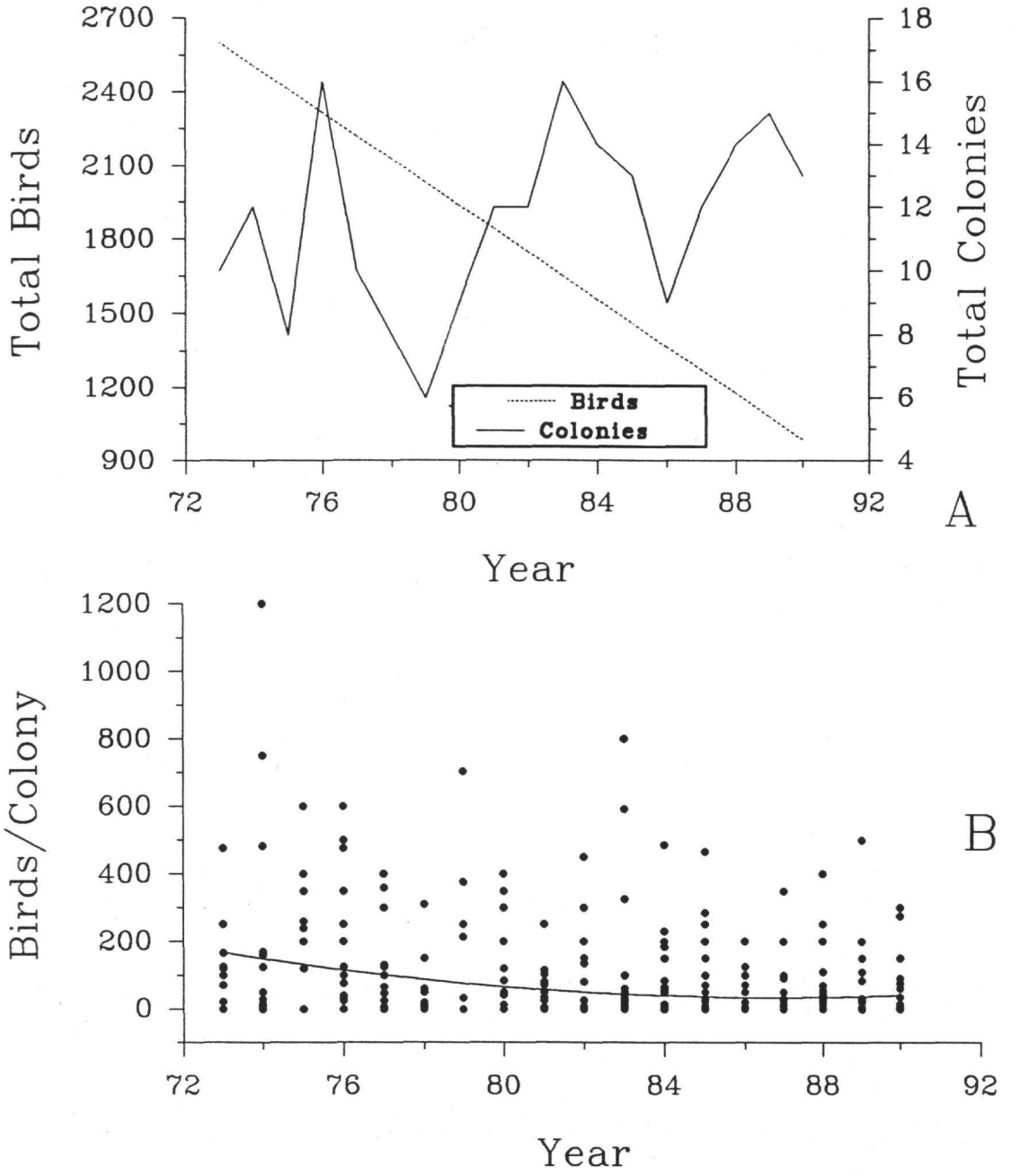

Figure 26. Trend in numbers of black skimmers per year (N=18) and the number of colonies containing black skimmers from 1973 to 1990 during Texas Colonial Waterbird Surveys. B. Individual colony counts and trend in numbers of black skimmers per colony from 1973 to 1990 (N=516) during Texas Colonial Waterbird Surveys. From Slack et al. (1992).

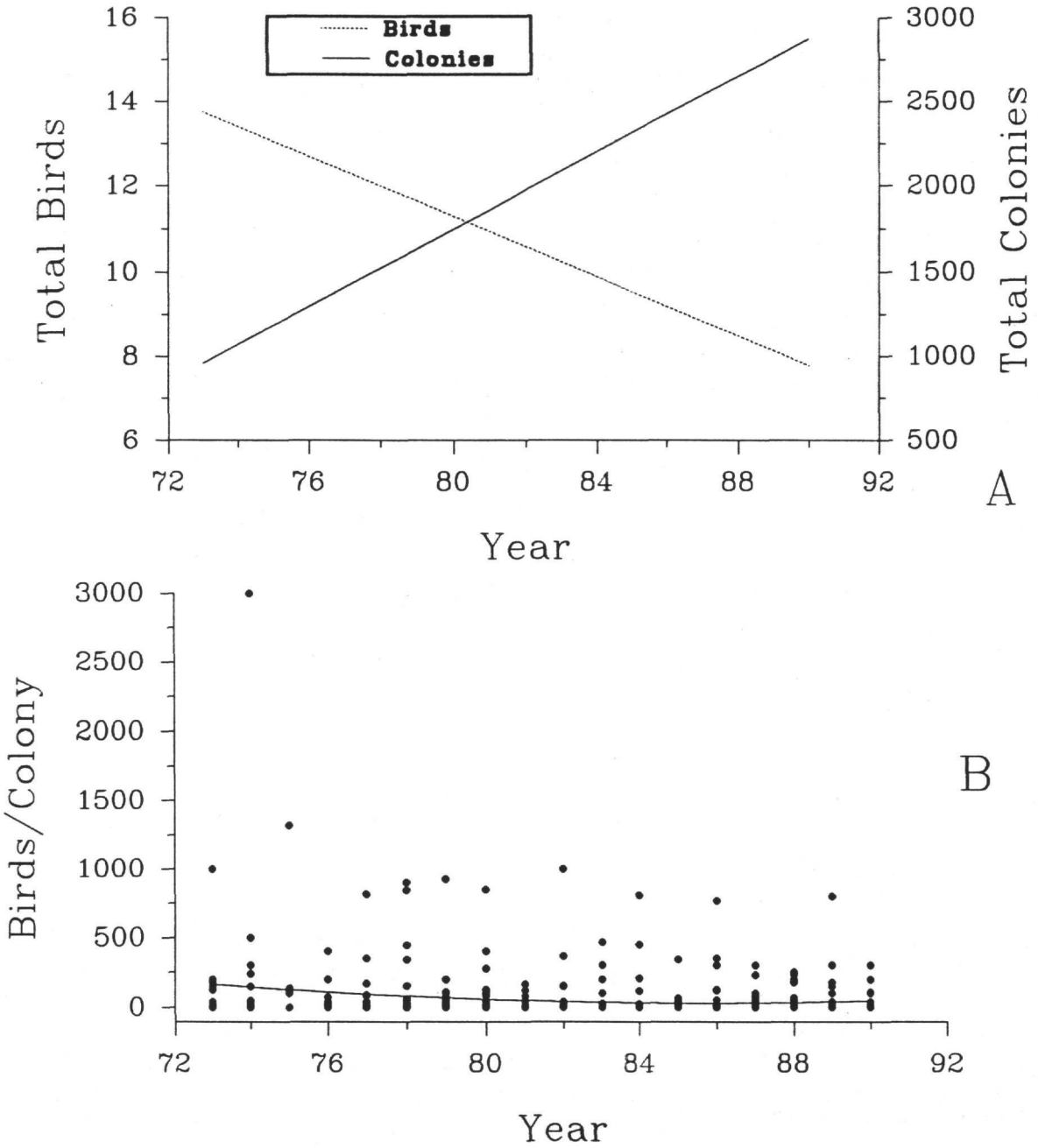

Figure 27. A. Trend in tricolored herons per year (N=18) and the trend in numbers of colonies containing tricolored herons from 1973 to 1990 during Texas Colonial Waterbird Surveys. B. Individual colony counts and trend in tricolored herons per colony from 1973 to 1990 (N=516) during Texas Colonial Waterbird Surveys. From Slack et al. (1992).

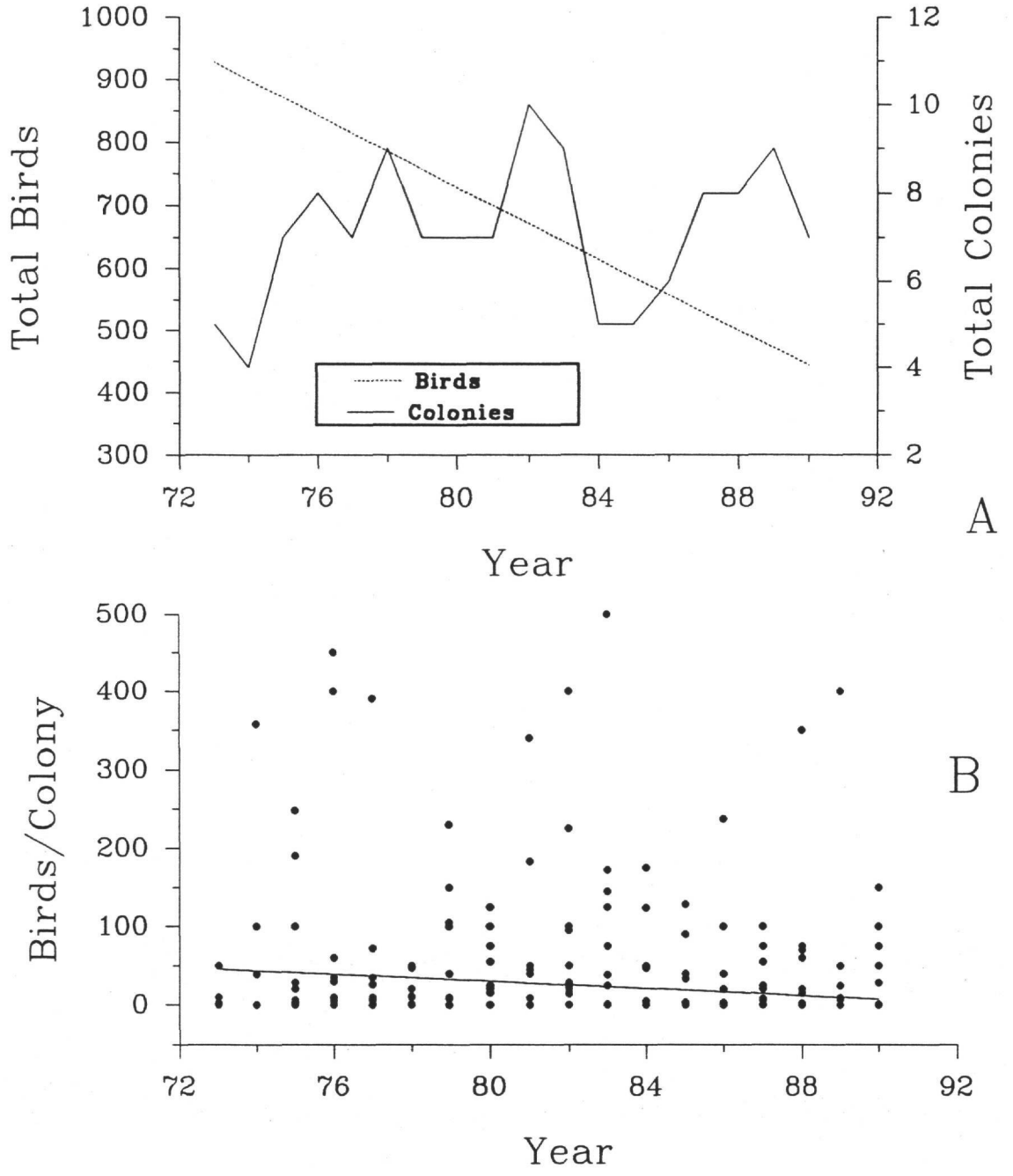

Figure 28. A. Total number of roseate spoonbills per year (N=18) and the number of colonies containing roseate spoonbills from 1973 to 1990 during Texas Colonial Waterbird Surveys. B. Individual colony counts and trend in roseate spoonbills per colony from 1973 to 1990 (N=516) during Texas Colonial Waterbird Surveys. From Slack et al. (1992).

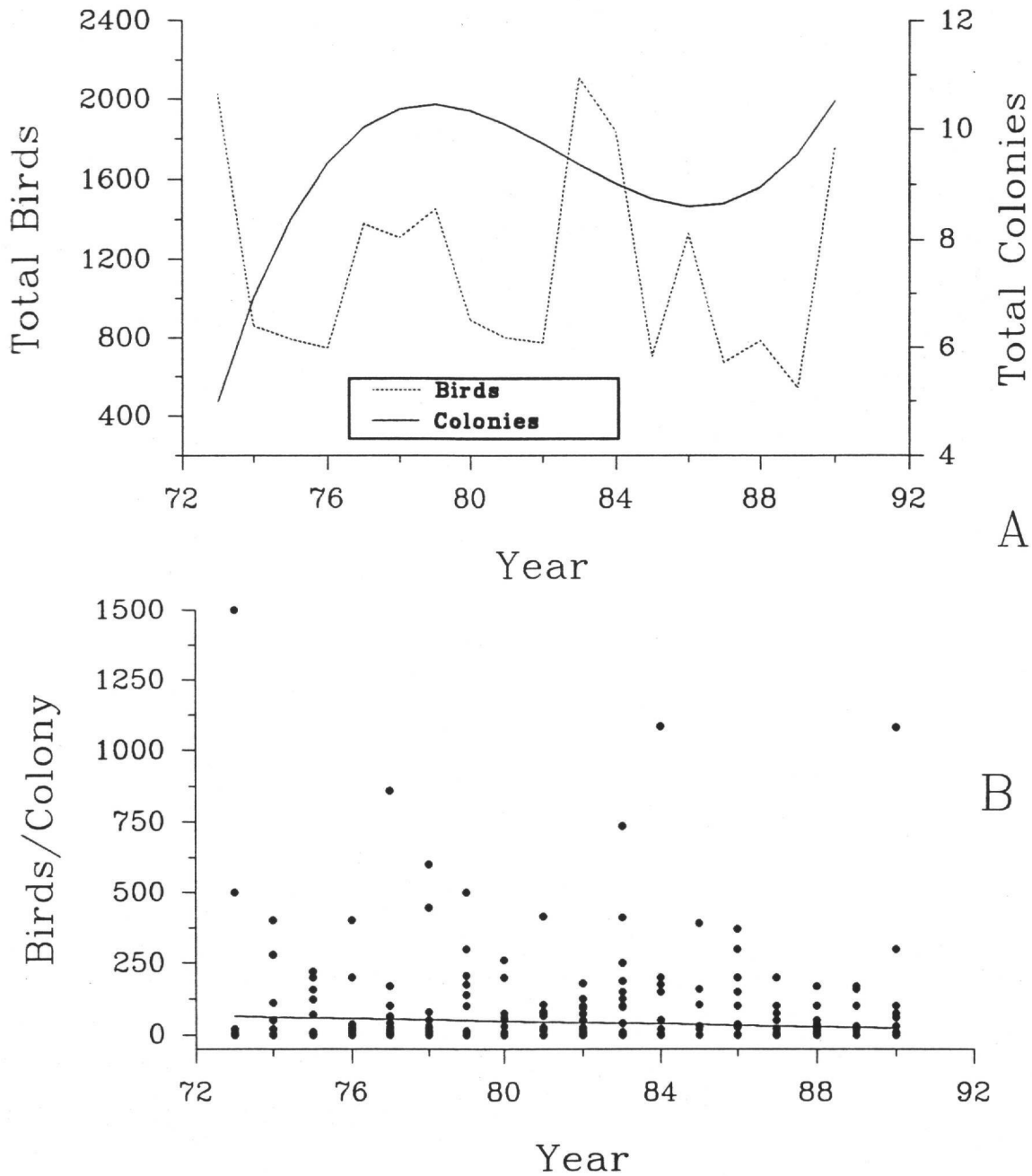

Figure 29. A. Total number of great egrets per year (N=18) and the trend in number of colonies containing great egrets from 1973 to 1990 during Texas Colonial Waterbird Surveys. B. Individual colony counts and mean number of great egrets per colony from 1973 to 1990 (N=516) during Texas Colonial Waterbird Surveys. From Slack et al. (1992).

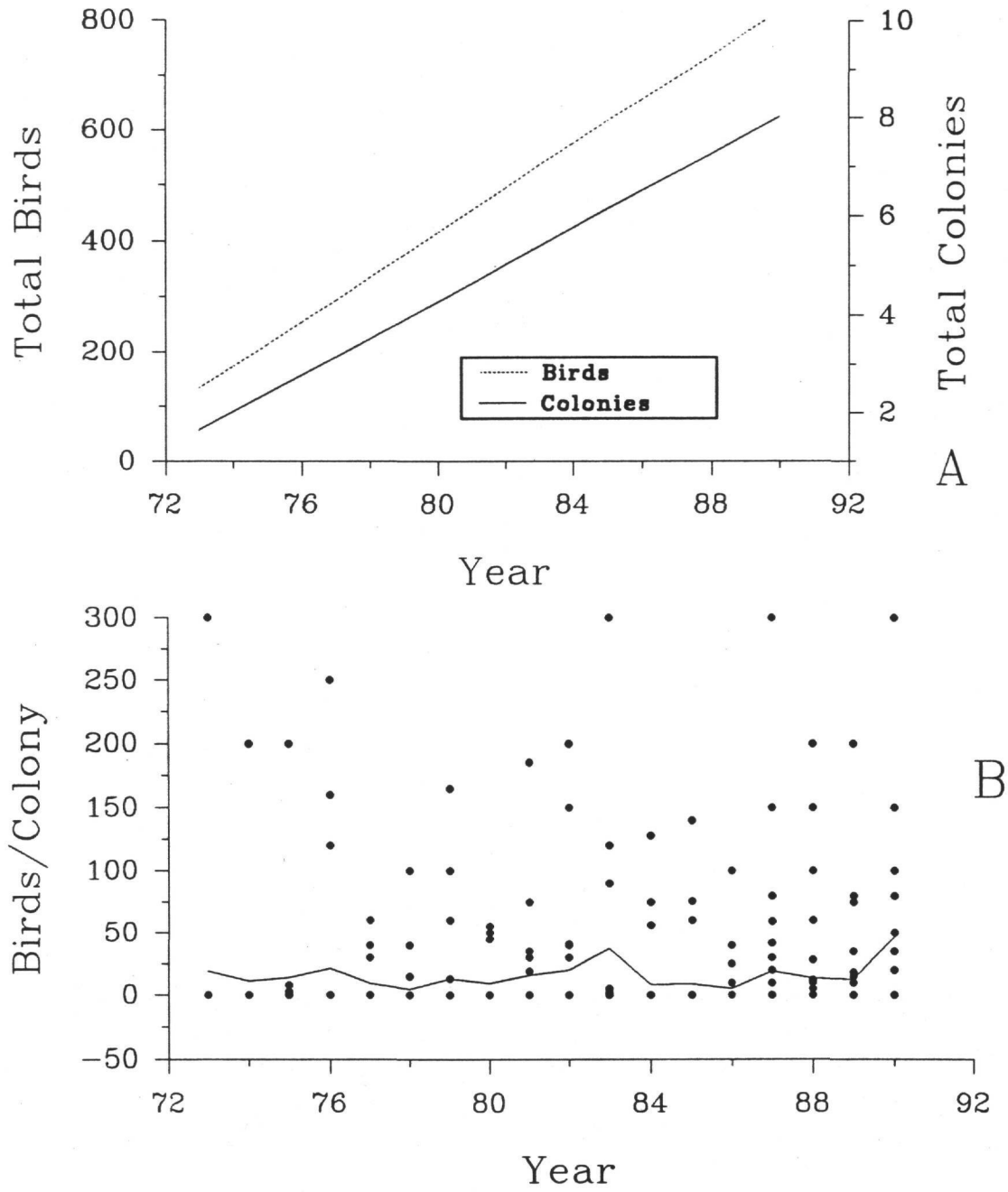

Figure 30. A. Trend in olivaceous cormorants per year (N=18) and the trend in number of colonies containing olivaceous cormorants from 1973 to 1990 during Texas Colonial Waterbird Surveys. B. Individual colony counts and mean number of olivaceous cormorants per colony from 1973 to 1990 (N=516) during Texas Colonial Waterbird Surveys. From Slack et al. (1992).

of the trends in colony number and colony size, lending credence to the conclusion that the number of colonies has generally increased. The increase in the number of colonies observed for both the open-water and the marsh group may also be the result of sampling bias, as more small colonies are discovered and added to the data base.

The true magnitude and exact timing of the trends are unknown because the time span covered by the Texas Colonial Waterbird Survey (1973 through 1990) may not be long enough to show its entire extent. The declines could be a normal life cycle of which only the downward portion was sampled. For long-lived organisms such as birds, a time series of several decades may be required in order to distinguish population cycles from superimposed trends. Historical sources (e.g. Strecker 1912, Williams 1938) mention the presence of species of birds no longer found in the Galveston Estuary region. At the least, it is valid to conclude that there has been long-term structural change in the bird community in the Galveston Estuary area.

Geographic extent

Birds are highly mobile organisms with patchy areal distributions. Colonies shift widely in space and time. Whether a species shows an increase, a decrease, or variation with little pattern depends largely on the size of the area covered, and larger population trends may be obscured by focusing on too small a scale (a single colony, a single refuge, a single estuarine system, or a single state). However, confining the geographic scale to the estuarine level is not inappropriate if it is recognized that the question being addressed is that of the health of the estuarine system, not the health of a species.

Probable causes

Possible causes for the declines in marsh-feeding birds are listed here in order of confidence and probability. The list is not comprehensive.

1) **Decrease in quantity of feeding habitat**. The loss of tidal wetlands is the most likely explanation for declining trends in marsh-feeding birds. As discussed in Chapter IV, roughly 19 percent of the Galveston Estuary's vegetated wetlands were lost between the 1950s and 1989 (White et al. 1993). Most of the loss probably occurred before the period of record of the Texas Colonial Waterbird Survey, but the trends shown in Figures 25-29 may reflect ongoing wetland loss and lagged effects on long-lived organisms.

2) **Decrease in quality of feeding habitat**. It is also possible that pollutants concentrate in the waters, sediments, or resident organisms of bay margin feeding habitat. Waterbirds are effective bioaccumulators of a variety of contaminants (King 1989). Buoyant materials, such as oil and grease, tend to concentrate in intertidal areas and could be specifically detrimental to wading birds and skimmers. In addition to the well-publicized oil spills, oil and grease are a large component of non-point source pollution (Newell et al. 1992) and are routinely released during activities related to oil transportation (Kennish 1992). King and Krynitsky (1986) found higher levels of DDE (a metabolite of the banned pesticide DDT) in black skimmers than in cormorants or

gulls, at levels known to cause reproductive problems in some species. White et al. (1984) found high residues of DDE in black skimmer eggs from the southern and mid-coast region of Texas. Oil field effluent is another potential source of contamination. Though there is no direct evidence that bird populations on an estuary-wide scale have been affected by pollution, it would be surprising if they were not.

3) **Decrease in food supply**. The quantity of prey fish is a special aspect of the quality of feeding habitat that can be tested using CF data. Bag seine samples probably approximate the prey available to birds feeding at the bay margin, though there is no control for the predator's bias or the prey's predator avoidance mechanisms. Figure 1A shows a general decline in small fish abundance in bag seine catches from 1982 through 1989, possibly corresponding to the declines in marsh-feeding birds between 1983 and 1990 (Figures 25-29). Figure 2A shows the CPUE for the 14 common species caught by trawl in the open bay (confined to individuals under 200 mm). The numbers of fish caught by trawl remained relatively constant and may correlate with the steady or increasing trends observed among birds that feed over open water.

These generalities must be interpreted with caution because detailed diet information for waterbirds, especially in coastal areas, is scarce. Wading birds apparently consume a wide variety of fresh, salt, and brackish water fish and invertebrates (Oberholser 1974, Telfair et al. 1982, King 1989). Killifish and sheepshead minnow, among the most important prey species to herons (Rex Wahl pers. comm.), declined over the 1978-1991 period (Figures 1L, 1M, 1N) though their numbers were fairly constant after 1980. A study by Morrison et al. (1977) showed the diet of nestling olivaceous cormorants in Sabine Lake to be dominated by sheepshead minnow (Figure 1N), striped mullet (Figure 1E), Atlantic croaker (Figure 1C), and sailfin molly, species that show no trend or declines between 1978 and 1991. The population of olivaceous cormorant nevertheless increased (Figure 30).

A closer examination of Figures 25-30 shows that peaks in the number of birds per colony tend to coincide in 1973-74 and 1983-84, during and following El Niño events. The possibility that ENSO affects bird populations is especially conspicuous for olivaceous cormorants (Figure 30), whose greatest numbers occur in the El Niño years 1973, 1983, 1987, and 1990. If ENSO affects fish populations and if food supply limits the abundance of wading birds, the high numbers of small fish in 1990-91 should result in a resurgence of birds feeding on them in 1992 or 1993.

4) **Increase in morbidity**. The role of disease, whether naturally occurring or aggravated by human activity, has received little attention. Spalding (1990, 1991) suggested the proliferation of parasitic nematodes in nutrient-rich eutrophic waters contributed to die-offs of wading birds in Florida. There is at least one report (Rex Wahl pers. comm.) of a die-off of black skimmer chicks in the Galveston Estuary area in 1989-90, caused by starvation or possibly parasitic infection. There are no data to demonstrate a disease problem in the Galveston Estuary, but the possibility should be investigated.

5) **Decrease in quantity or quality of nesting habitat.** Many factors can be deleterious to single colonies: inundation and erosion from rising relative sea level; wetland drainage or sedimentation creating a connection between a bird island and the mainland, allowing invasion by raccoons or other predators; changing vegetation, caused by cattle egret guano or by normal succession (Telfair in press). Increased predator density associated with human activity (e.g. feral dogs and cats, garbage-eating raccoons) and direct disturbance by humans may also contribute to a decline in the number or size of bird colonies. Fire ants are locally a problem and should definitely be monitored, though premature or incorrect treatment for fire ants may cause worse problems (such as disturbance, contamination, or the resurgence of ectoparasites).

All the factors above are undoubtedly important locally. However, they would be expected to affect all colonial waterbirds that nest together, not just those with similar feeding habitat. The proposed creation of new nesting islands for colonial waterbirds (Glass 1992) would probably be favorable for colonial waterbirds in general but should not be pursued at the expense of vegetated wetland habitat.

6) **Natural cycles.** The recognition that bird populations may be linked to small fish populations (cause 3 above) and climate cycles raises the possibility that the perceived declines are driven by high counts early in the available time series. Given a longer time series, there may be no net trend. However, visual inspection of the variability in Figures 25B, 26B, 27B, 28B, and 29B suggests that authentic declines may be superimposed on ENSO-related variation. Black skimmers are the most dramatic example because the peaks in birds/colony declined steadily (Figure 26), in spite of the relative strength of the climatic events. Olivaceous cormorants peaked during the El Niño years 1983, 1987, and 1990, but black skimmers did not.

WATERFOWL

A discussion of declines in waterfowl is necessarily general, in part because local monitoring has been less effective than for colonial waterbirds. Waterfowl are monitored by the Mid-winter Waterfowl Transects, providing reputable data but only available for the past five years; and by the Mid-winter Waterfowl Cruise Count, a good source of long-term records but impractical for trend analysis because there is no control for effort.

Mottled ducks, northern pintails, and blue-winged teal showed a decline in population (Figures 31, 32, 33). Only mottled duck are not migratory. Northern pintails and blue-winged teal have been declining nationwide since the 1950s (Figure 34). These species are probably most strongly affected by factors outside of Texas, such as the loss of small wetlands to agriculture and development in their breeding grounds on the Great Plains (e.g. Pederson et al. 1989), or conditions in Central and South American wintering grounds (Stutzenbaker and Weller 1989). There is little definitive evidence, however. The most probable local cause of declining waterfowl populations is the loss of freshwater marsh habitat (discussed in Chapter IV). White et al. (1993) estimate that

35,600 acres of fresh marsh in the Galveston Bay region were lost between the 1950s and 1989, most of them drained and converted to uplands.

Other factors possibly contributing to waterfowl population trends on the Texas Gulf Coastal Plain are numerous but hard to quantify (Cain and Feierabend 1988). Though Cain (1988) detailed the problem of contaminated wintering waterfowl habitat, Hobaugh et al. (1989) reported that controls on the use of pesticides resulted in a decrease in pesticide-related mortality in Texas since the 1970s. Avian cholera may have caused die-offs of waterfowl with increasing frequency through the 1980s on the rice prairies of Texas (Hobaugh et al. 1989), though the factors contributing to the severity of the disease and its possible effect on population levels are unclear. The ingestion of lead shot was probably a problem for several species of waterfowl, especially mottled ducks (Moulton et al. 1988). The regulated use of steel shot instead of lead has probably reduced the degree of lead toxicity. However, such measures probably will not immediately restore mottled duck populations.

It is interesting that while some species of ducks show declines (Slack et al. 1992), geese have generally increased (Haskins 1990). Geese appear to be more efficient in using the winter rice fields of Texas than are ducks (Bateman et al. 1988, Hobaugh et al. 1989). They also adapt to a variety of breeding habitats, whereas ducks are more closely tied to aquatic habitats (Pederson et al. 1989). While those ducks that breed in the prairie pothole country are losing their wetlands to farming, snow geese breed in the Arctic, beyond intense competition with agriculture. Possibly the decline in ducks is favorable to geese. The numbers of geese on the Texas Gulf coast will probably decline as rice farming is lost to other land uses, specifically to development (Bateman et al. 1988). Furthermore, snow geese may be increasing to the point where populations will decline because of overcrowded breeding grounds.

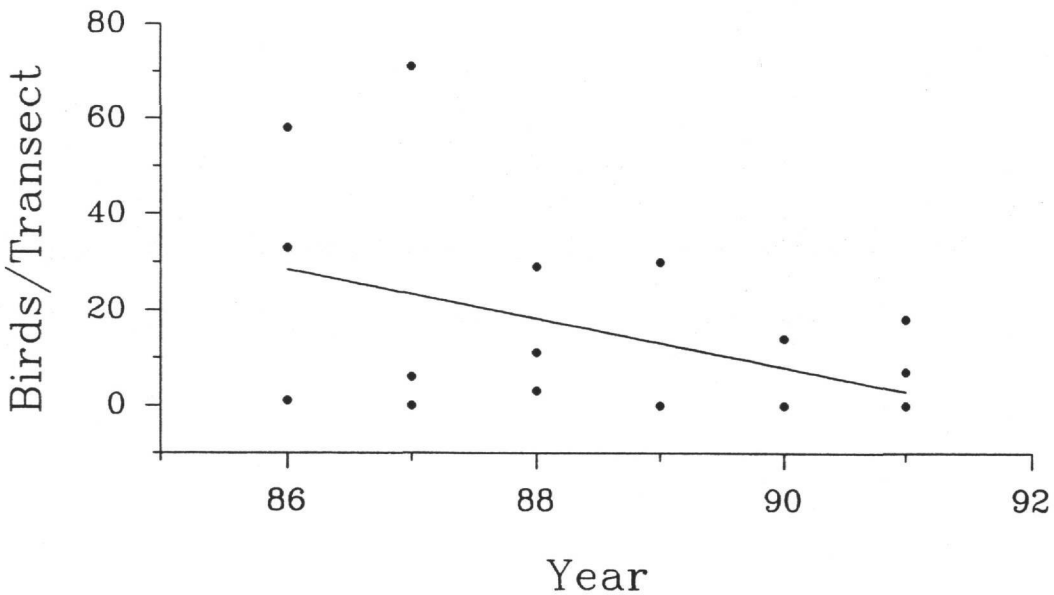

Figure 31. Individual counts and trend in mottled ducks from 1986 to 1991 (N=18) during Mid-winter Waterfowl Transects. From Slack et al. (1992).

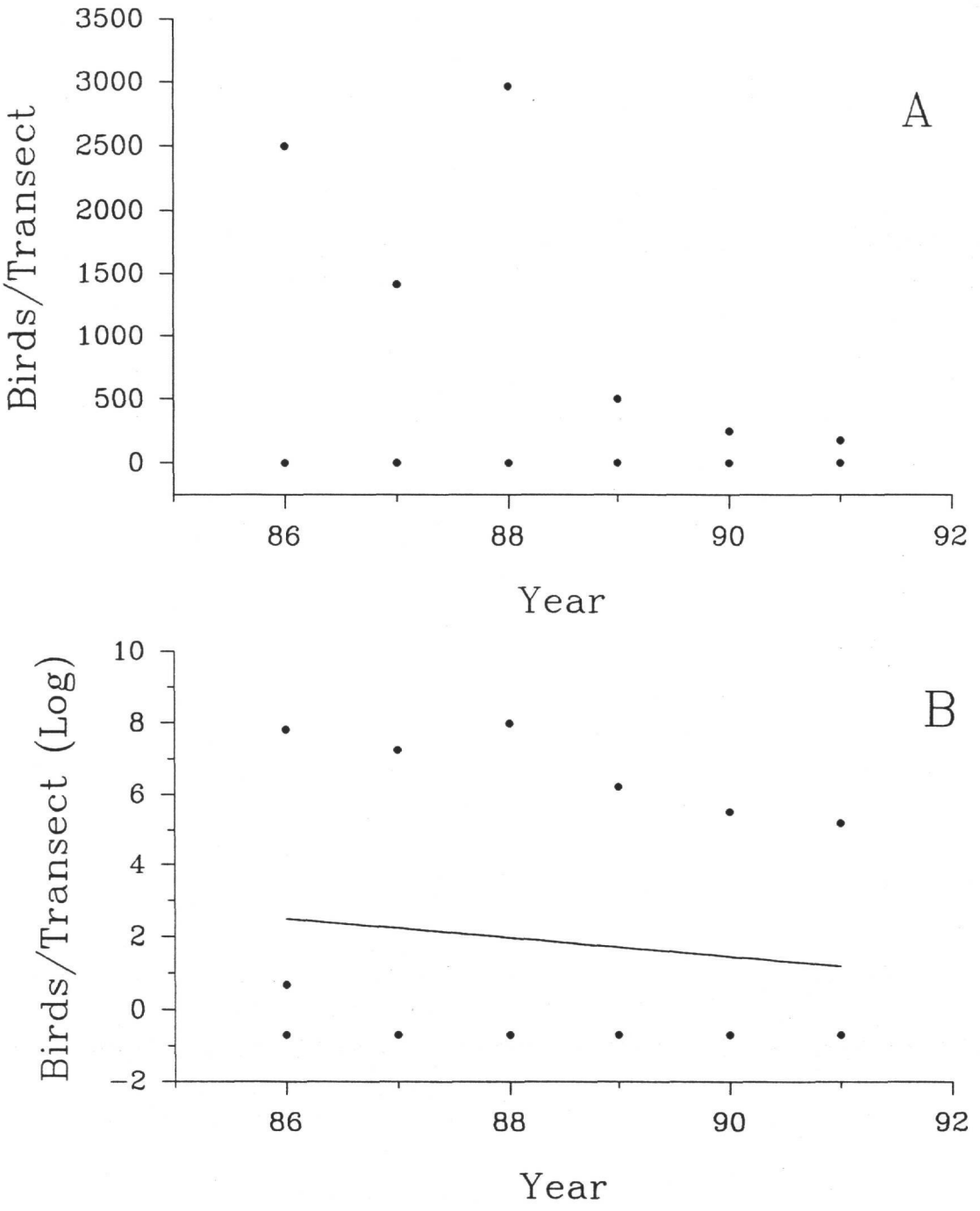

Figure 32. A. Numbers of northern pintails per transect from 1986 to 1991 (N=18) during Mid-winter Waterfowl Transects. B. Trend in northern pintails from 1986 to 1991 (N=18) during Mid-winter Waterfowl Transects. From Slack et al. (1992).

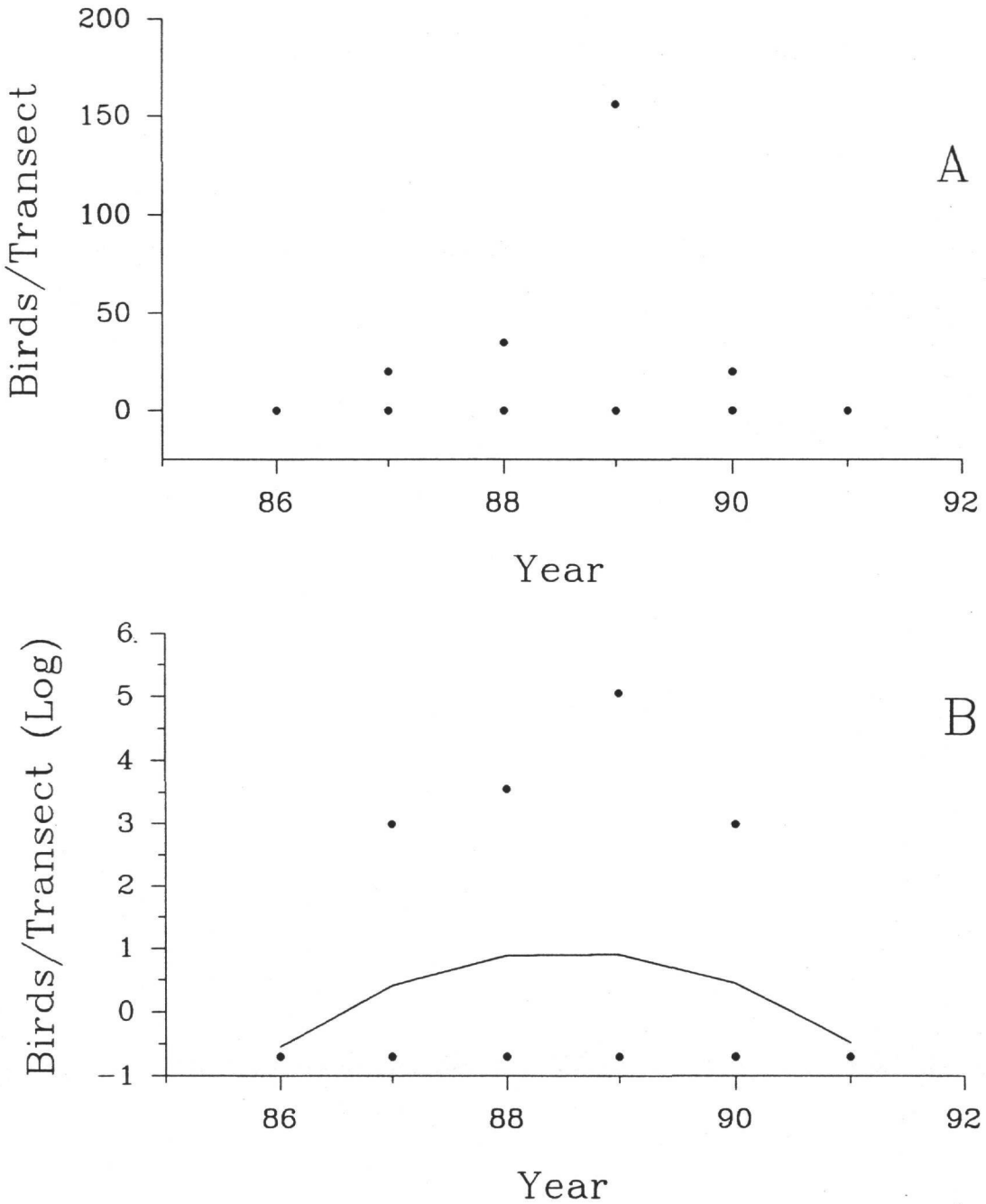

Figure 33. Numbers of blue-winged teal per transect from 1986 to 1991 (N=18) during Mid-winter Waterfowl Transects. B. Trend in blue-winged teal from 1986 to 1991 (N=18) during Mid-winter Waterfowl Transects. From Slack et al. (1992).

SHOREBIRDS

Slack et al. (1992) reported a possible increase in shorebird populations based on data from the Christmas Bird Counts and the Bolivar Flats Shorebird Surveys. The Christmas Bird Count data should be interpreted with caution, however, because of the high variability in effort. The Bolivar Flats Shorebird Surveys also indicate there has been at least a local increase. However, Neill (1992) reported a loss of shorebird habitats throughout North America during the 1970s and 1980s, and declines in shorebird populations in north-central Texas over the last 10 years.

DISCUSSION AND CONCLUSIONS

Birds are relatively conspicuous members of the estuarine community and have a record as indicators of environmental problems. Declining brown pelican, osprey, and falcon populations in the 1960s raised alarms about the bioaccumulation of pesticides and led to the nationwide ban on DDT. Royal terns and brown pelicans both feed on open-water fish and both show strong increases in their use of the Galveston Estuary in recent years (Slack pers. comm.). This is probably the result of reduced pesticide pollution (Stanley 1989).

Wading birds are valuable as estuarine indicator species. The eggs and chicks of herons and egrets have been used to test for contaminants (specifically, DDE and PCBs) as part of the National Contaminant Biomonitoring Program (Custer et al. 1991), because of their high trophic level, relatively regular nesting habits, and tendency to bioaccumulate contaminants. The decline in marsh-feeding birds documented by Slack et al. (in prep.) is cause for concern. Unlike the declines in waterfowl, marsh-feeding birds are probably responding to relatively local stresses. The most probable causes are local (estuary-wide) wetland loss (from bulkheading, subsidence, and development) and/or contamination. Background data on parasitization and contaminant body burden in birds throughout the bay would be relatively inexpensive to acquire and potentially revealing. Black skimmers should be specifically targeted for such a study.

The disappearance of waterbird colonies could have serious consequences for nutrient cycling in the estuary. Powell et al. (1991) showed that seagrasses in a Florida estuary increased in biomass as a consequence of nutrient input from bird colonies. Other birds also probably play important, but poorly understood, roles in the estuarine food web. Continued declines in birds, especially waterfowl, will disappoint birdwatchers and hunters, and adversely affect the area's tourist industry.

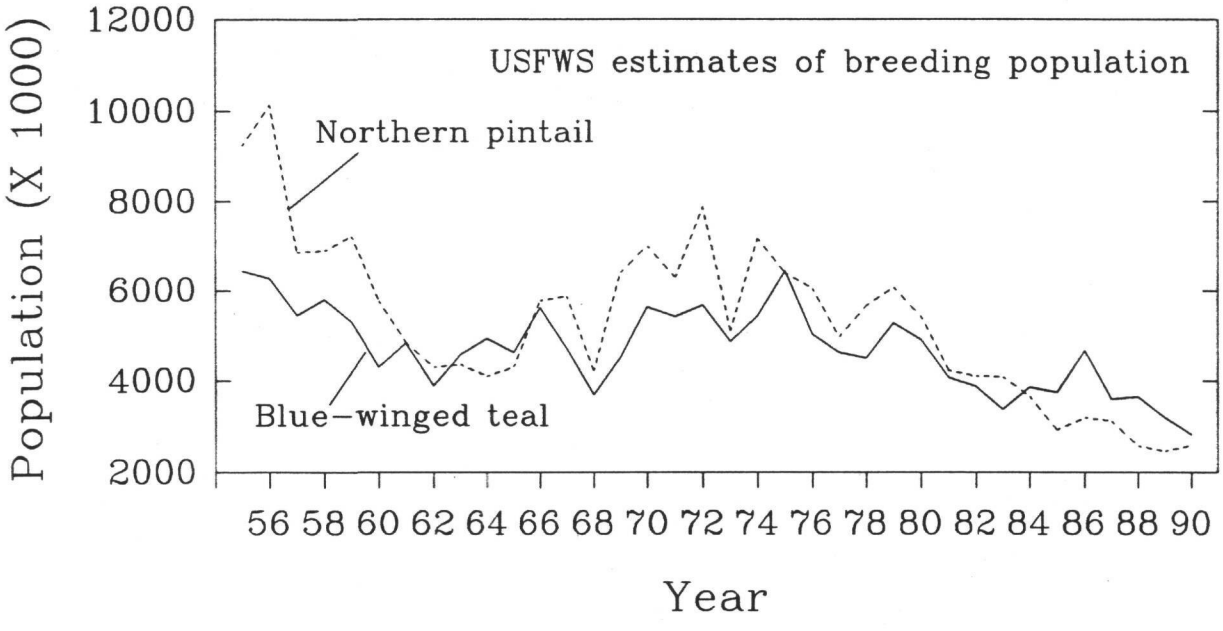

Figure 34. Annual population estimates for northern pintails and blue–winged teal in North America. Data from U. S. Fish and Wildlife Service.